

# NOTES 21: CLT-BASED INFERENCE FOR DIFFERENCES

Stat 120 | Fall 2025

Prof Amanda Luby

## 1 CLT Recap

CLT for 1 Proportion

$$\hat{p} \sim N(\text{_____}, \text{_____})$$

$$SE_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$$

But, we don't know  $p$ , so plug in \_\_\_\_\_ (CI's), \_\_\_\_\_ (HT's), \_\_\_\_\_ (conservative)

CLT for 1 Mean

$$\bar{X} \sim N(\text{_____}, \text{_____})$$

where  $SE_{\bar{X}} = \text{_____}$ . But, we don't know  $\sigma$ , so we plug in  $s$ . Then,

$$\frac{\bar{X} - \mu}{\frac{s}{\sqrt{n}}} \sim t_{n-1}$$

Example We want to build a 99% confidence interval for  $\mu$ , where  $\bar{X} = 290$ ,  $n = 120$  and  $s = 87.6$ . The correct form for the CI is:

## 2 CLT for a difference in proportions

Idea:

Population parameter:

Sample statistic:

CLT:

$$\hat{p}_1 - \hat{p}_2 \sim N(\text{_____}, \text{_____})$$

How big is "big enough?"

- $n_1 p_1 > \underline{\hspace{2cm}}$
- $n_2 p_2 > \underline{\hspace{2cm}}$

What is the SE?

$$SE_{\hat{p}_1 - \hat{p}_2} = \sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$$

but, we don't know  $p_1$  or  $p_2$ . Three options:

1. "Plug-in"  $\hat{p}_1$  and  $\hat{p}_2$
2. Use  $\hat{p}_{pooled} = \underline{\hspace{2cm}}$
3. "Conservative" SE: assume  $p = \underline{\hspace{2cm}}$

CLT-based confidence interval for a difference in proportions:

$$\hat{p}_1 - \hat{p}_2 \pm z^* \times SE_{plug-in}$$

CLT-based test for a difference in proportions:

$$H_0 : p_1 - p_2 = 0$$

$$z = \frac{(\hat{p}_1 - \hat{p}_2) - 0}{SE_{pooled}}$$

### 3 CLT for a difference in means

Idea:

Population parameter:

Sample statistic:

CLT:

$$\bar{x}_1 - \bar{x}_2 \sim N(\mu_1 - \mu_2, SE_{\bar{x}_1 - \bar{x}_2})$$

How big is "big enough?"

Case 1:

- $n_1 > \underline{\hspace{2cm}}$
- $n_2 > \underline{\hspace{2cm}}$

Case 2:

- $n_1 \leq \underline{\hspace{1cm}}$  or  $n_2 \leq \underline{\hspace{1cm}}$
- AND

What is the SE?

$$SE_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$$

but, we don't know  $\sigma_1$  or  $\sigma_2$ , so we plug in  $s_1$  and  $s_2$  instead:

$$SE_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

the sampling distribution is no longer a normal distribution, but becomes a \_\_\_\_\_

CLT-based confidence interval for a difference in means:

$$\bar{x}_1 - \bar{x}_2 \pm t_{df}^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

CLT-based test for a difference in means:  $H_0 : \mu_1 - \mu_2 = 0$

$$t_{df} = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where  $df =$  \_\_\_\_\_

## 4 CLT for Matched Pairs

Idea:

Population parameter:

Sample statistic:

CLT:

How big is “big enough”?

What is the SE?

CLT-based confidence interval for a matched pairs difference:

CLT-based test for a matched pairs difference:  $H_0 : \mu_d = 0$